Introduction

Maternal nutrition and subsequent weight gain during pregnancy are crucial for the proper development of a fetus. The Institute of Medicine classifies optimal weight gain during pregnancy in categories based on body mass index (BMI)[1]. The amount of recommended weight gain during pregnancy is inversely related to the BMI of the mother with the recommendation that the underweight mother gain the most weight during pregnancy[1]. A number of factors can cause a mother to consume inadequate nutrition, in quantity, quality, or both and prevent appropriate weight gain and ideal growing conditions for the fetus. One of these factors is anorexia nervosa (AN), an eating disorder that causes obsessions over food and weight. This can lead to a weight status below the healthy weight for height or age[2]. It has been estimated that 0.3-3.7% of women in the United States will experience AN in their lifetime and the occurrence is most prevalent during child bearing years[3].

Another factor that can negatively affect the growth and development of a fetus is alcohol consumption during pregnancy. Alcohol is a known teratogen and can affect prenatal and/or postnatal growth, the central nervous system causing disruptions in normal brain development, and facial abnormalities. Fetal alcohol spectrum disorder (FASD) is an umbrella term that covers a range of outcomes related to fetal alcohol exposure including previously mentioned outcomes as well as sudden infant death and spontaneous abortions[4]. Every year in the United States approximately 757,000 women drink alcohol while pregnant[5]. FASD occurs in 0.5-2 per 1000 births nationally[6]. While alcohol has this direct effect on the fetus, indirect effects in the form of nutrient deficiencies also pose a risk for the fetus. Vital nutrients derived from food are often replaced by calories from alcohol which causes not only a lack of macronutrients such as protein and fat, but also micronutrients, many of which are of great importance during

pregnancy. When alcoholism is combined with the calorie restricting of AN, the nutrient deficiencies often become even greater.

Anorexia Nervosa: Fertility

The role that anorexia nervosa plays in fertility is unclear. Some research shows no significant difference in fertility rates between women with anorexia nervosa and controls[7,8], while more recent studies demonstrate higher rates of women seeking treatment at infertility clinics who have a history of AN[3,9]. One study found the rate of women with a history of AN seeking treatment at an infertility center to be five times greater than the prevalence rate of AN in the US[3]. One cause of infertility may be the presence of amenorrhea which can persist even after a patient has recovered from an eating disorder[10]. A study by Copeland et al. found that loss of menses was associated with low body weight and the presence of affective disorder[10]. Leptin, a hormone secreted from adipose tissue, is needed in adequate levels to promote ovulatory regularity. Levels of leptin decrease as body weight decreases, therefore, the low leptin levels are likely the cause of menstrual irregularity and amenorrhea associated with AN[11]. Return of menses has been associated with weight gain and increases in leptin and was also quicker in women who had shorter durations of eating disorders[10,11]. Therefore, it is likely that the length of AN and the extent of body fat loss play a role in fertility.

While infertility rates among women with AN may be elevated, women with this disorder continue to get pregnant. Even if enough body weight has been recovered to regain menses, eating disorder symptoms may not be fully recovered causing continued calorie restriction and inadequate weight gain during pregnancy. In addition, women may carry a false sense of

security that they are unable to conceive while experiencing amenorrhea but this is not always true. When the first ovulation occurs after a period of amenorrhea, a woman can conceive and therefore not experience subsequent menstruation due to the new pregnancy[12]. Rates of unplanned pregnancies among women with AN were found to be significantly higher than in the general population[12]. While the threat of restricting calories during pregnancy exists for women who suffer from AN, other risky health behaviors may also be present due to the false assumption of the inability to conceive while experiencing amenorrhea. Such behaviors may include alcohol consumption or drug use.

Anorexia Nervosa: Weight Gain and Nutrient Intake

Once pregnant, women with anorexia nervosa may struggle to gain enough weight to provide for the growing fetus. Research in this area is limited, however, in a study determining weight gain attitudes in pregnant women, it was found that while 40.3% of women without eating disorders were concerned about gaining weight during pregnancy, 91.1% of women with AN were concerned[13]. While it may be expected that women with AN would gain an inadequate amount of weight during pregnancy, data from the Norwegian Mother and Child Cohort Study showed that women with AN had a greater weight gain during pregnancy than women without eating disorders[14]. However, despite the weight gain, the quality of diet may suffer. In the Avon Longitudinal Study of Parents and Children, it was found that women with a history of AN have been linked to both lower protein and fat consumption as well as lower micronutrient intake, in particular, folate[15]. Low protein intake has been linked to increased fetal exposures to cortisol which affects fetal stress response and has been linked to lower birth weights[15]. One hypothesis

is that poor nutrition and subsequent protein restriction, with the addition of stress and depression caused by AN, can lead to elevated levels of glucocorticoids in the fetus and CRH in the mother. This elevation in glucocorticoids can cause growth restriction, low birth weight and developmental effects later in life[15]. Poor nutrition leading to low folate and/or hypoglycemia can also cause developmental problems such as neural tube defects and low birth weight. While rates of adequate weight gain remain undetermined, it seems poor quality of nutrition is evident.

Anorexia Nervosa: Birth outcomes

Birth outcomes in women with anorexia nervosa have also become a controversial topic. Commonly reported complications include increased rates of cesarean sections, increased rates of preterm delivery, and increased rates of small for gestational age infants (SGA)[8,16]. A study by Kaouba et al. found no difference in rates of cesarean sections or preterm deliveries, however, they document increased rates of lower head circumference, SGA, and microcephaly[17]. Many of these complications found in increased rates in mothers with AN were disputed, however, by a large, prospective cohort study conducted in Sweden. The Swedish study found the only difference between women with AN and women without this disorder was lower birth weight, a trait confirmed by most studies[16,18,19,20], but found no difference in rates of SGA or cesarean sections. A study by Bulik et al. actually showed lower risk for preterm birth and cesarean sections in women with AN[14]. Taken together, it is difficult to reach a conclusion when it comes to birth outcomes and AN due to the different results found by a number of studies. Of the two largest, most recent studies, one analyzed AN and bulimia nervosa together and showed a significant increase in rates of low birth weight, SGA, and preterm delivery in women with

eating disorders[16]. A study by Ekeus et al., the larger of the two studies, compared only women with AN to controls. The results of this study found an increased rate of low birth weight and decreased rate of cesarean sections among women with AN[18]. These two studies were comprised of women who had been treated at a hospital for AN indicating severity of disease, and both used national registries to obtain information. Studies on this topic were based in a variety of countries around the world where health care practices may differ, and may have contributed to the differences in outcomes. The only consistent outcome derived from these studies is low birth weight, likely a result of low maternal weight.

Alcoholism: Fertility

While anorexia nervosa and its relationship to reproductive health and birth outcomes is inconclusive, the relationship between alcohol consumption and reproductive and fetal health is clear. Alcohol consumption, like AN, has been linked to higher rates of infertility. Research shows a dose relationship between difficulty of conception and alcohol consumption where heavy drinkers are the most likely to experience fertility problems[21,22]. This may be due, in part, to the oxidative stress that is caused by alcohol consumption. Oxidative stress is caused by many different types of exposures and has been linked to infertility. Markers of oxidative stress have been shown to be elevated in women with higher alcohol consumption and play a role in oocyte development, maturation, and quality[23,24]. As with AN, even though infertility may be higher in these populations, pregnancy is still possible.

Alcohol: Birth Outcomes

Studies researching the relationship between alcohol and fetal alcohol spectrum disorders demonstrate a dose relationship between the amount of alcohol consumed and the severity of the effects of FASD. No specific low dose of alcohol has been deemed safe for pregnancy[25]. It has been shown that the amount of alcohol ingested, as well as the length of time over which the fetus experienced alcohol exposure, and the stage of development of the fetus when exposed, all affect the severity of FASD[26]. In addition to these factors, maternal weight and BMI have also been found to have an effect on the severity of FASD. A study by May et al. found that women with lower body weight and BMI are correlated with more severe FASD likely due to the fact that blood alcohol concentrations are more highly elevated in the absence of food in the stomach prior to drinking, as well as the lower amount of total body water found in individuals of lower weight status[27].

Both anorexia nervosa and alcoholism during pregnancy are significant health problems that require treatment by a team of health care professionals including a registered dietitian. When these problems arise in unison, the situation becomes more challenging to treat. The case study that follows may aid in translating the complications associated with nutrition in a patient presenting with both AN and alcohol dependence while pregnant.

The Case

JC is a 29 year old, Caucasian female with a past medical history of anorexia nervosa and alcoholism. She was to be voluntarily admitted to the Eating Disorder's Partial Hospitalization Program at UNC Hospitals where patients spend weekdays at the hospital and then practice the skills they acquire at home at night and on weekends. JC is 62 inches tall and when she arrived

at UNC, she weighed 40.1kg, 70% of her ideal body weight, and had a BMI of 16 classifying her as underweight. She reported severe weight loss of more than 10kg (20%) over the previous six months. Due to the fact that she had lost 7% body weight less than one month prior to admission to the program and was at a significantly lower weight than at the time of her referral, as well as having experienced a recent alcohol relapse, she was voluntarily admitted to the inpatient program instead of the partial program.

JC reported that she had been struggling with AN since she was fifteen years old. Since then, she has had three episodes of significant weight loss and eating disorder symptoms including excessive exercise, binging, purging, and restricting. She explained that her eating disorder usually coincides with her bouts of alcoholism which are both often initiated by depression. When she drinks, she restricts food intake due to her fear of excessive caloric intake as well as to prevent a diffused effect of alcohol with food. She reported her recent activity as eating one meal per day and walking four miles every day. She was diagnosed with osteoporosis in 2008 and had been hospitalized for both AN and alcoholism in the past. At the time of her alcohol relapse that precipitated her referral to UNC, she had been sober for 27 days. JC blamed her relapse on the fact that her housemate, who is also her Alcohol Anonymous sponsor, was going out of town. Since JC is very dependent on her sponsor, the thought of being alone for a week had caused her to begin drinking again. Due to her alcohol use, JC was also separated from her husband of three years.

Upon arrival to the UNC eating disorders program, JC was diagnosed with anorexia nervosa and alcoholism. JC identified her 'fear foods' as starches, sweets and anything fried. She was put on a regular diet when she was admitted and the only nutritionally pertinent medication she was prescribed was a daily multivitamin which was appropriate due to her

inadequate intake and likelihood of not meeting her micronutrient needs without it. She had not been taking a multivitamin prior to admission. Her nutritionally pertinent labs were normal except for her creatinine which was low likely due to malnutrition and low muscle mass. Her nutritional diagnoses were "Underweight related to eating disorder as evidenced by BMI 16 and 70% IBW" and "Malnutrition related to eating disorder as evidenced by anthropometric data and severe weight loss (7% body weight loss <1 month prior to admission)." Her target weight was 50 kg and a BMI of 20. Her nutritional goals while in treatment included meeting her estimated energy and protein needs, 1-2kg of weight gain per week, gaining knowledge of the exchange system to be able to individually plan meals meeting 100% of her nutrient needs, and to monitor for re-feeding syndrome given her poor nutritional intake for an extended period of time. Re-feeding syndrome is a condition of abnormal organ function due to inappropriate re-feeding following a prolonged period of poor or no nutritional intake. These abnormalities are due to the rapid influx of magnesium, phosphorus, and potassium into the cells and out of the bloodstream upon initiation of the re-feeding process. This can be minimized or prevented by administering a slow progression of food while monitoring the affected electrolytes closely and repleting them as needed[28].

Nutrient needs were initially assessed by using basal energy expenditure which was calculated to be 1,085 kcal. To promote weight gain of 1kg per week, approximately 1,000 extra calories should be added to this baseline number each day. However, due to her prolonged poor intake, JC's needs were estimated more conservatively to minimize the likely effects of re-feeding syndrome. Her initial estimated needs were 1,400 kcal per day and 70 grams of protein per day, 20% of her total energy needs. With this estimation of calories to attempt to minimize electrolyte imbalances, JC was still monitored very closely and her electrolytes were repleted if

the magnesium, phosphorus, or potassium daily lab values were low. Her weight was also monitored daily and after a couple of days on this caloric dose, increases were made based on her weight change with a goal of 1-2 kg of weight gain per week.

Twenty three days after admission to the inpatient eating disorders unit, JC had gained 5.2 kg, had a BMI of 18.2 and was 79% of her ideal body weight. She was on a 2,300 kcal diet and was eating 100% of her meals, was challenging herself to eat fear foods such as dinner rolls, mashed potatoes, and french toast, had a good understanding of the exchange system, and was able to plan her own menus using this principle. At this time, JC was taking vitamin D and calcium supplements in addition to her multivitamin due to osteoporosis, and a fiber modular to promote bowel regularity. She was moved to the Eating Disorder's Partial Hospitalization Program where she was able to attend group classes and remain in the hospital during the day while practicing her new eating skills at home at night and on the weekends. She successfully planned outings to restaurants and was finding that she was choosing foods based on her food preferences rather than on caloric content. JC remained in the Partial Program for three weeks and was discharged in March with plans to move back in with her AA sponsor.

Her treatment plan seemed to be working well until she was readmitted to the hospital in May. She was four months pregnant at this time and had lost weight since her discharge in March. According to the new Institute of Medicine guidelines, JC needed to gain 13-18 kg (28-40 lbs) during her pregnancy with a goal of 0.5-0.6 kg (1-1.3 lbs) per week in the second and third trimesters[1]. This rate of weight gain, however, is based on the assumption that 0.5-2 kg (1.1-4.4 lbs) had been gained in the first trimester which was not the case for JC. Since she had lost 1 kg (2.2 lbs) during the first four months of her pregnancy, her weekly weight gain goals needed to be more aggressive so that by week 40 of her pregnancy, she would be at the weight

needed to promote healthy growth and development for the fetus. By week 40 of her pregnancy, JC's weight goal was 64.5 kg (142 lbs). She had to achieve a significant amount of weight gain in the second half of her pregnancy to meet this goal. Upon re-admission, her nutrition diagnoses were "Underweight related to eating disorder as evidenced by % IBW" and "Malnutrition related to eating disorder as evidenced by inability to gain adequate weight for pregnancy." She was put on prenatal vitamins and additional folic acid to ensure adequate micronutrient intake during pregnancy. Her estimated nutrient needs were initiated at 1600 kcal, again to start conservatively due to the chance of re-feeding syndrome and progressed aggressively to the number of calories needed to meet weekly weight gain goals. Her caloric dose was increased after her phosphorus, magnesium and potassium remained normal. JC's weight was monitored and evaluated daily and if she was not gaining adequately, her daily calories goals were increased. She already had previous knowledge of meal planning based on the exchange system due to her time in treatment a few months prior, so she was able to quickly get back into the flow of the unit. Ten days after re-admission into the Partial Program, JC's estimated nutrient needs had increased to 2200 kcal per day and she had already gained 1.7 kg in that time. JC's ethanol level was tested frequently due to her past history of alcoholism and ten days into her admission it was found to be elevated indicating alcohol consumption. Due to this new finding, it was recommended that she be enrolled into the inpatient program to better address her needs and to prevent her access to alcohol. She refused inpatient treatment and requested to be discharged against medical advice.

In September, when she was 30 weeks pregnant, JC was admitted once again to UNC Hospitals, this time for binge drinking. At this point she had only gained 5 kg (11 lb) during her pregnancy when her goal was 13-18 kg. Not only was she unable to maintain her daily caloric intake, but she was also having a drinking relapse. It became obvious that she was unable to take

care of herself and her unborn child without constant supervision and she was admitted to a rehabilitation center for the remainder of her pregnancy. Unfortunately, the fetus was already showing signs of microcephaly as a result of alcohol consumption. Even with the months of support for her eating disorder and alcoholism, it is unlikely that JC's child will be born healthy.

Discussion

Appropriate weight gain during pregnancy is linked to the mother's pre-pregnancy weight[1]. As is the case with anorexia nervosa, a woman who is underweight at the time of conception has to gain more weight than women who are normal weight, overweight or obese in order to provide enough nutrients to the fetus for proper growth and development. Research over the past twenty years has found mixed results concerning the amount of weight gain achieved by women with AN during pregnancy. This could be due, in part, to the many discrepancies found between methods of recruitment, levels of severity of the disorder, and methods of previous treatment, if any. Even though research reports varied outcomes in weight gain, from this case report it seems clear that a woman who is suffering from AN at the time of conception is likely to have difficulties gaining the appropriate amount of weight.

The case of JC is complex as her pregnancy was complicated by both alcoholism and anorexia nervosa, issues that affect hundreds of thousands to millions of women in the US each year[5]. While it is thought that both of these conditions reduce one's chance of becoming pregnant, JC was able to conceive while her weight was below 80% of her ideal body weight.

During her time as an inpatient, JC was able to not only demonstrate her ability to discontinue her alcohol use, but also to show that she is capable of gaining weight and applying nutritional knowledge to her meal planning. She showed significant progress in her confidence

and ability to make healthy food choices and to remain sober, but these traits were only present in the inpatient setting. It seems that in cases of AN during pregnancy, especially when alcoholism is a variable, every effort should be made to have the patient remain under supervision with a strong support team. Apparently, JC was not receiving the same type of constant support from her family and friends as she was receiving from the hospital programs, although this is difficult to assess. It is also imperative to talk to women in JC's situation about reproductive health, birth control, and the consequences of pregnancy during the acute phase of disorders such as hers. The consequences of inadequate weight gain and inadequate nutrient intake during pregnancy, as well as alcoholism during pregnancy, are severe for both mother and unborn child. This case reiterates the importance of nutritional guidance and emotional support for patients dealing with alcoholism and eating disorders during pregnancy.

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